WEST
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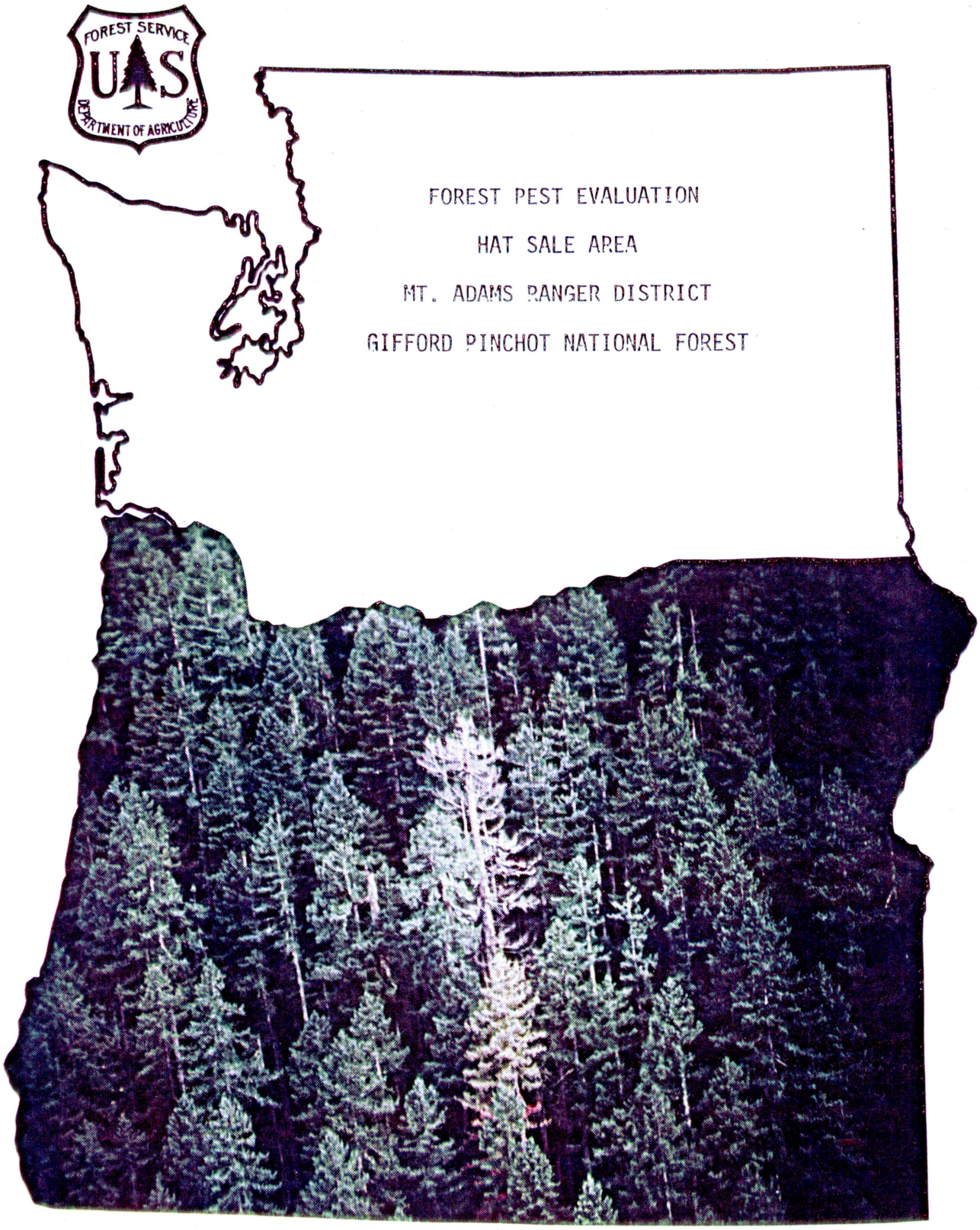
Forest Pest Management
Pacific Northwest Region



FOREST PEST EVALUATION

HAT SALE AREA

MT. ADAMS RANGER DISTRICT

GIFFORD PINCHOT NATIONAL FOREST

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FOREST PEST SURVEY
HAT SALE AREA
MT. ADAMS RANGER DISTRICT
GIFFORD PINCHOT NATIONAL FOREST

by

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INTRODUCTION

During portions of August and September, 1984, Forest Pest Management personnel did a forest pest survey within part of the proposed Hat Timber Sale. This area is on the west slopes of Head Peak (T. 4 N., R. 9 E., secs. 1, 2, 11, 12). The areas examined included all initially proposed harvest units and most of the potential alternatives within the management block (Figure 1). Purposes of the evaluation were to determine causes and amount of pest losses, identify and map problem areas, and develop management recommendations aimed at minimizing current and future losses. This information was requested by the District for use in finalizing management plans and alternatives for the proposed timber sale.

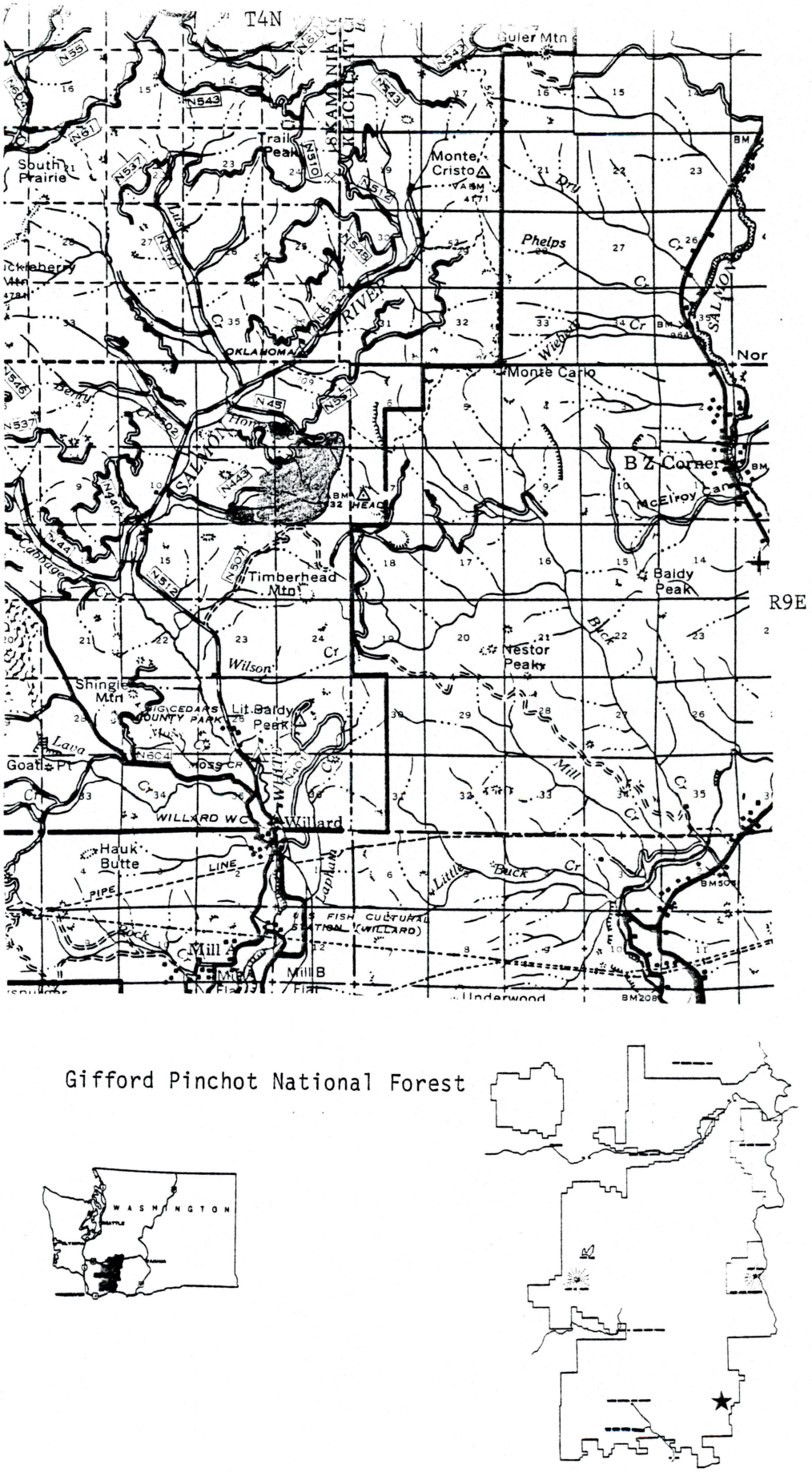
STAND CHARACTERISTICS

Site quality in the survey area is generally very good, especially in the lower elevations. Towards the higher ground on Head Peak, site quality degrades as soils become shallower, and numerous rock outcrops are encountered. Several small streams originate on the west-facing slope of Head Peak.

The majority of stands of natural origin within the area are approximately 120 years old. Another age class, represented by an area of much smaller size, is 30 to 35 years old. All these stands were naturally established following wild fires. Several young plantations are in and around the survey area. These were not surveyed.

Conifer stand composition is made up of almost pure Douglas-fir. A few western hemlocks are present, mostly toward the eastern portion (and highest) of the block. Some western redcedars are present near wet areas, especially stream courses. A very few western white pines are also present. Hardwoods, including bigleaf maple and red alder are fairly common throughout the block.

Most timber harvesting in the area has been clearcutting by cable systems. A few helicopter-yarded units are scattered throughout the area. Some salvage logging had been done in recent years near road systems and on gentle-to-moderate slopes accessible to ground lead equipment. It was apparent that most salvaging was mainly to capture bark beetle and/or disease caused mortality. No other stand management has been done.


T4N
R9E
Gifford Pinchot National Forest
WASHINGTON
Trail Peak
Monte Cristo
Phelps
Monte Carlo
BZ Corner
Baldy Peak
Timberhead Mtn
Nestor Peak
Shingle Mtn
Lit. Baldy Peak
Willard
Hauk Butte
Mill
Mill B
Underwood
South Prairie
Buler Mtn
Wilson
Lava
Goat Pt
Berry
Blackberry
Wiener
McElroy
Black
Little Black
Salmon
Clearwater
Cummings
Horn
Mill
Lapham
Pipe
Line
Rock
Wildcat
Moss Cr
Willard Cr
Fish Culture Station (Willard)
Big Cedars County Park
Oklahoma
Kamania
Klickitat
Dru
Cr
Creek
River
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N55

METHODS

The area examined (Figure 2), included sites with merchantable stands which could be entered in the proposed Hat Timber Sale. District personnel identified areas of highest priority, which were surveyed. Within lower-priority areas, only stands identified as preliminary planned units were evaluated. In total, three blocks were surveyed.

Transects were run at 5-chain (330 ft.) intervals across the survey blocks. The survey area was scrutinized at close to 100 percent coverage for pest-caused decline and mortality. This was done by reconnoitering a 2-1/2-chain wide strip on either side of the line. Root disease centers were mapped with boundaries based on the furthermost extent of dead or symptomatic trees. This information was used to make a composite map of the entire area (Figure 2).

Approximately 590 acres were surveyed systematically, using a variable radius plot method. Plots were placed at 10-chain (660 ft.) intervals along lines. A Spiegal-Relaskop was used to define each plot, and a basal area factor (BAF) of 40 was used.

Each plot was examined for evidence of disease or insect infestation. This included dead and dying trees, old stubs and stumps, and less than normal stocking. Dead trees and trees exhibiting symptoms of root diseases were examined to determine the causal pest. This involved (a) removing a section of bark from the boles of dead trees to check for bark beetles or their galleries, and (b) removing a section of bark on one or more sides of the root collar and exposing and dissecting portions of two or more large roots to check for stained wood or mycelia of root disease fungi. In plots containing root disease or insect infestation, the following data were collected for each tree in the plot: tree species, DBH, general condition (live, dead, standing, down), and presence of insects and diseases. Similar data were collected for every fifth plot throughout the survey, regardless of the health of the trees on that plot. From this information, mean basal area and number of trees per acre by tree species, DBH class, condition, and pests were calculated.

RESULTS AND DISCUSSION

Mean basal areas and trees per acre are shown in Tables 1 and 2. Percentage of Douglas-fir dead due to all causes is 10.5 percent. Most mortality was directly and indirectly due to root rot, especially laminated root rot, caused by Phellinus weirii. Centers of disease and insect-caused mortality are shown in Figure 2.

Several other diseases induced lesser amounts of loss. These included Armillaria root rot, caused by Armillaria mellea, and brown cubical butt rot, caused by Phaeolus (Polyporus) schweinitzii. Douglas-fir beetle (Dendroctonus pseudotsugae)-caused mortality was significant.

LOCATION OF PEST-CAUSED DAMAGE

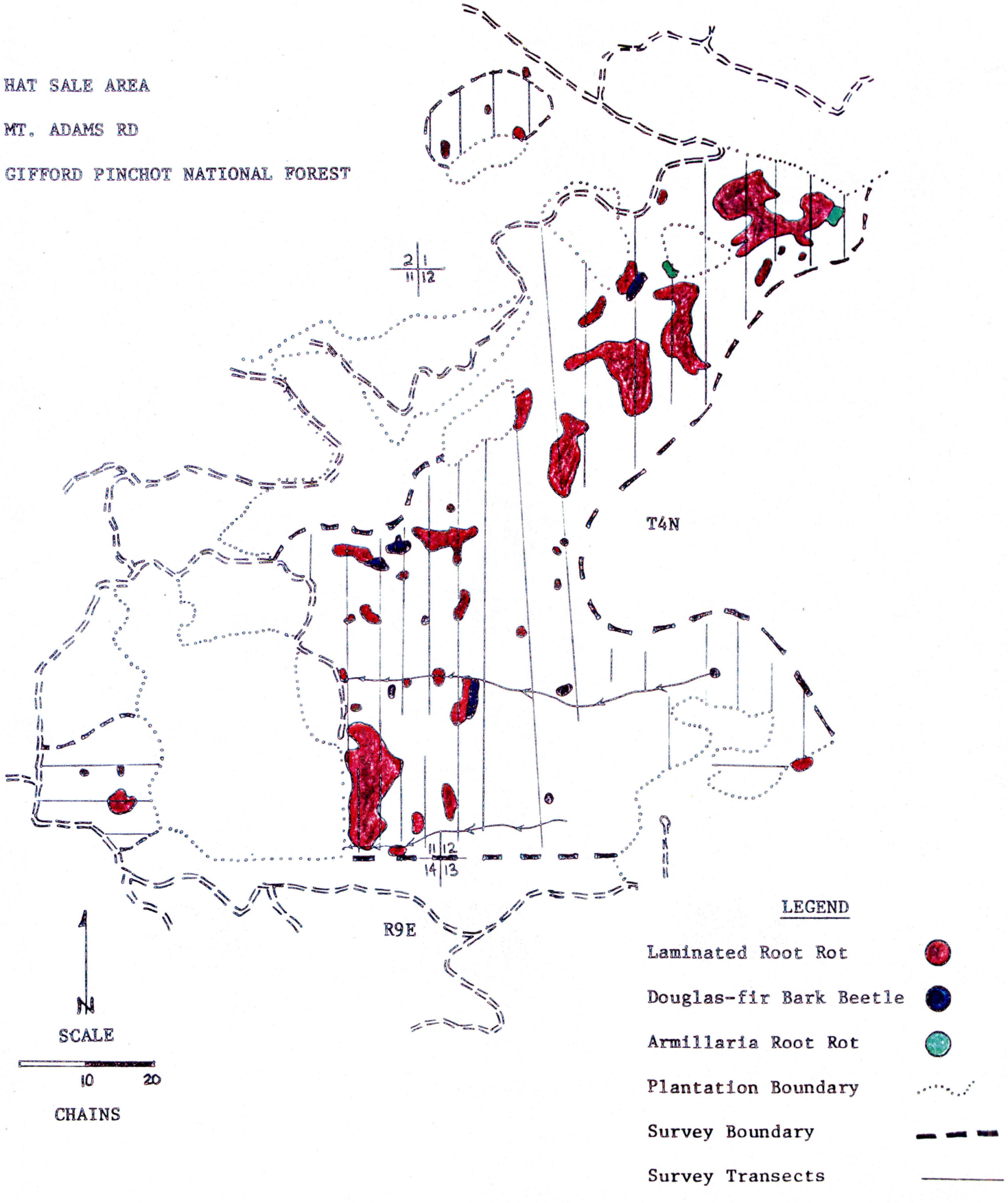

Figure 2

CLS 12/84

Laminated root rot was the most frequently encountered mortality-causing disease throughout the survey area, but only 2.3 percent of all Douglas-fir were identified as being killed by P. weirii alone. Root rot-caused mortality is usually underestimated in cruise plots because old dead trees, unstocked or understocked disease centers are not directly quantified. Tallied dead trees within plots represent a portion of the impact. On plots without laminated root rot, mean Douglas-fir basal area was 250 $ft.^2$ On plots with at least one dead or dying tree infected with P. weirii, mean basal area was 133 $ft.^2$ or 53 percent of uninfected plots.

Laminated root rot was found throughout most of the survey area. Most severely infected regions of the block were the lower elevation stands on the southern portion and a band that runs NW-SE between the northwest-facing breaks and the high elevation rocky ground/small timber in the northern half of the block.

Almost all disease was found in the older age class stands. Minor and scattered infection was found in pole-sized timber. While disease is suspected to be more widespread than in the older age classes, active mortality has not yet become very apparent in the pole-size stands.

Many Douglas-firs within or on the perifery of infection centers are probably infected, yet have not started to exhibit crown symptoms; they are not identified as being infected in the survey. Based on recent studies done in British Columbia and eastern Washington, we suspect that only 50 percent of the number of trees actually infected produced crown symptoms.

In mature stands, trees may be infected for 20 to 30 years before crown symptoms are visible. Tree death following infection usually takes much longer in mature stands than in pole- or sapling-sized stands. Oftentimes, mortality of root rot-affected trees is directly caused by windthrow or bark beetle attack.

Douglas-fir beetles have caused extensive mortality in this area. Most helicopter-yarded cutting blocks were the result of salvaging bark beetle and root disease/bark beetle-killed timber. In the survey area, 2.4 percent of the total Douglas-fir stems killed have evidence of beetle attacks. Most insect-caused mortality was within and adjacent to root rot centers. In numerous cases, nearby healthy or trees on which root rot was not detected were attacked and killed by the insect. In the Hat area, evidence suggests that while endemic populations of beetles have continually attacked root rot-affected trees, sporatic epidemic populations of insects have developed and pockets of timber have been killed. Population buildups have probably been the result of root rot-induced windthrow in years following major windstorms.

Brown cubical rot, caused by P. schweinitzii, was found in 0.5 percent of the total Douglas-fir basal area. This is a considerable underestimate because this disease is not recognized unless the fruiting bodies are seen or the distinctive decay observed on dead trees. No living infected trees were identified in the cruise. However, only on plots where all trees were tallied and DBH measured would fruiting bodies have likely been seen. Occurrence of brown cubical rot was widely scattered and, when seen, was found on single trees or, less frequently, very small groups.

Red ring rot, caused by Phellinus (Fomes) pini, was observed throughout the survey at moderate levels. Infected trees were tallied only in plots where all data were taken. A P. pini infection level of 2.5 percent of the basal area of all trees was found. Most Northwest conifer species are prone to damage by this pest. Douglas-fir is one of the most susceptible. Damage to stands, including proportion of stand infected and decay in individual trees, increases with age.

Armillaria root rot was found in the survey area. Most damage was to single scattered trees or small groups of trees. Two centers are shown in Figure 2. Mode of action, levels of loss, and condition of trees being attacked all are characteristic of A. mellea acting as a passive pathogen. Some strains of this fungus are extremely virulent and cause extensive mortality. This condition was not observed during this survey. Armillaria root rot was identified in cruise plots and mortality attributed to this pest was 0.3 percent of the total basal area.

DISEASE BIOLOGY AND IDENTIFICATION

Laminated root rot

Laminated root rot is a common disease in Pacific Northwest stands. In western Washington and Oregon, it is by far the most damaging forest disease. An estimated 5 percent of the area in West Side Douglas-fir stands is in laminated root disease centers. Most damage occurs in young, sapling-sized stands through mature timber. Old stands frequently have increased stocking of later successional, shade tolerant species which are also less susceptible to root disease.

Laminated root rot damages its host by attacking, killing and decaying its roots. Infection spreads on the surface of roots, coming in on one or more roots to the root collar, then spreading from there outward into other roots. The period of time for initial infection to progress to mortality is somewhat proportional to the size of the tree (root system). During the time between initial infection and subsequent death, rate of tree growth diminishes as compared to similar, uninfected trees.

Mortality frequently results from windthrow of trees which have a portion of their root system decayed. On more sheltered aspects, trees may die standing or topple when most of their structural support is gone. As mentioned, bark beetles will frequently attack dying trees, resulting in quickened tree death.

Variability in species susceptibility exists in western Washington mixed-conifer stands. The most susceptible species in the survey area is Douglas-fir; western hemlock is intermediately susceptible. Western white pine is a very minor stand component in this area; it is tolerant in susceptibility to P. weirii. Western redcedar is resistant to infection. All hardwoods are immune. Bigleaf maple and red alder are the principal hardwood trees growing in the survey block.

Laminated root rot can be identified from a variety of signs and symptoms. The disease usually causes trees to die in patches or groups in pole-sized or larger stands. Infected trees exhibit crown symptoms, including reduced height growth, and thinning and chlorotic foliage. Trees will usually be severely infected before crown symptoms are apparent. Such trees are prone to windthrow. Disease patches usually will appear as pockets of dead and down trees, with infected trees exhibiting crown symptoms at the periphery. Less susceptible species, such as hardwoods or western hemlock, may proliferate in disease centers, obscuring evidence of laminated root rot. In old-growth stands, laminated root rot may be especially difficult to detect because crown symptoms are usually less apparent in infected older trees.

Diseased windthrown trees will frequently exhibit root balls; remnants of root systems that are decayed and broken off just below the root collar. Exposed decayed wood will usually have characteristic delaminations along the annual rings, pitting, and growth of reddish-brown setal hyphae between the sheets of decayed wood (Plate 1).

Living-diseased and recently-killed trees will often have whitish, crusty ectotrophic mycelia of the fungus growing on the surface of infected roots. On larger roots of older trees, this mycelium often is found in bark crevices.

P. weirii can survive as a saprophyte for up to 50 years on dead host material (large roots and stumps). New infections occur when roots of healthy susceptible trees contact this material. Laminated root rot can thus remain on the site, infecting subsequent generations. Centers develop when the pathogen grows from diseased trees and infects healthy trees via root contacts or grafts. The rate of expansion can be as much as 1 to 2 feet per year. Stands stocked by less susceptible species may slow the rate of expansion.

Douglas-fir Beetle

The Douglas-fir beetle is an opportunistic insect, usually maintained at endemic levels by periodic mortality such as storm-damage, windthrown and disease-killed trees on which it feeds and reproduces. When a large amount of host material becomes available and conditions are favorable, outbreaks can occur. Storm-damaged and stressed trees are the preferred host material and are attacked first. If preferred host material is not available, the beetles will attack healthy trees and can kill them if attack densities are high. Brood production is usually poor in such trees and outbreaks decline rapidly over a 2- to 3-year period.

The Douglas-fir beetle has one generation annually. Adults and some large larvae overwinter. The adults emerge and attack from April to June. Some adults reemerge and attack additional trees. Adults from overwintering larvae emerge and attack in July and August.

In western Washington, host vigor is the main factor which keeps the beetle under control. Populations which rapidly build up because of abundant host material quickly subside because the beetles do not thrive on healthy green timber.

Red-brown Butt Rot

Red-brown butt rot is common in mature to old-growth Douglas-fir. The fungus causes decay of the root system and butt of its host. The pathogen is usually not very aggressive, and tree decline is slow following infection. Tree mortality usually results from windbreak or windthrow as a result of the decay. One or more other pests may be associated with mortality.

This disease commonly occurs at endemic levels in mature to overmature Douglas-fir stands. Special control measures are seldom required. Reinfection of new stands following harvest and regeneration does not appear to be a problem. Root contacts are probably the primary cause of spread within stands. Most infection centers include only a few trees.

The presence of "velvet-top" fruiting bodies is the best indicator of the disease. Trees which have "wind-broke" will exhibit the characteristic brown cubical rot caused by the fungus.

Red-ring Rot

Red-ring rot is a stem decay found in many conifer species. Individual trees will often have extensive decay throughout the bole. Losses increase with stand age, both as a result of number of trees infected and the amount of decay within each tree. Wood with advanced decay retains some structural strength and currently has some uses such as plywood core. Infected trees can be identified by the presence of fruiting bodies, and in many cases, swollen "punky knots." Spread of disease is by airborne spores infecting trees through branch stubs and possibly wounds.

Armillaria root rot

Armillaria root rot is found throughout the Northwest on a variety of hosts. In western Washington, this disease most commonly is found in plantations, especially where offsite stock was planted or local stock was poorly planted. Stressed trees of most species and all age classes are susceptible to attack. Douglas-fir is most susceptible when it is less than 30 years old. Occasionally, virulent strains of this fungus cause mortality to most species and age classes on a site. In some cases, A. mellea will be damaging only one species in a stand.

As with laminated root rot, A. mellea can cause group mortality. Disease spread is similar, occurring across root contacts or grafts. Infective string-like fungal structures called rhizomorphs can also spread the fungus a short distance through the soil. In some cases, this disease causes scattered mortality. Most often, centers are small.

Crown symptoms caused by Armillaria root rot often include chlorotic foilage and/or a distress cone crop. Resinosis around the base of the bole is very common. Cream-colored mycelial fans are often found growing under the bark of the lower bole on the root collar and roots of infected trees (Plate 2). These can also be found on trees which have been dead for up to 3 years. The presence of rhizomorphs is also very diagnostic.

Plate 1. Laminated decay and setal hyphae characteristic of Phellinus weirii.

Plate 2. Mycelial fans characteristic of Armilleria mellea.

ALTERNATIVES AND MANAGEMENT RECOMMENDATIONS

Pests are causing significant losses in the proposed Hat Sale area. Current and future losses can be minimized through appropriate stand management. This can include options of prioritizing areas for treatment, species manipulation, and length of rotation.

The most serious pest problem in the survey is laminated root rot. Not only is this disease causing significant losses on its own, it is directly and indirectly responsible for most of the Douglas-fir beetle-caused mortality. Approximately 62 acres within the survey area are within laminated root rot centers. This represents 10.5 percent of the total area. While root disease is present over most of the area, it is highest in the lower-elevation stands in the southern portion of the block and in a mid-elevation band through the north of the unit. Within these zones, laminated root rot can be characterized as being severe. Minimizing losses should be a high priority when formulating sale plans.

Deferring treatment in severely diseased stands will result in additional yield losses and expansion of root disease centers. If Douglas-fir were grown on untreated diseased sites, yield losses would approach 50 percent by rotation age.

Current and future losses can be minimized and conversion of diseased areas to a more healthy condition can be achieved by implementing a long-range integrated management scheme. The information in this report should be used in the planning and decisionmaking process for determining unit locations, total treatment area, silviculture system(s) and regeneration.

The following recommendations are suggested.

Mature Stands

Mature timber makes up the bulk of the stands in this area. They have the highest levels of loss. Stands are currently suffering mortalilty, continued spread of infection and loss of productivity in unstocked and understocked areas. These stands should be given highest priority for treatment. Regenerating these stands following harvest will require precautions to prevent future losses.

Laminated root rot can only be effectively treated as a process that starts prior to stand reestablishment. Following clearcut harvest of the existing infected stand, less susceptible species must be planted or infective material must be removed or rendered sterile if disease losses are to be reduced.

Planned unit layout should incorporate centers of disease shown in Figure 2. This can be done a variety of ways; using numerous small units or fewer large units where two or more disease centers are consolidated. Use of larger units is usually preferable because costs are minimized, allowing generation and collection of KV funds needed to effectively accomplish disease management work.

The survey map (Figure 2) depicting areas of root disease should be used as a locality map only. Delineation of root disease boundaries on the map is accurate to within one chain along and near transects and two chains between transects. Unit layout crews should be familiar with signs and symptoms of laminated root rot to aid in locating boundaries.

Extent of disease centers within cutting units should be identified on the ground prior to logging and immediately after felling. For 3 to 4 weeks after exposure, red-brown stain is usually present on cut surfaces of infected stumps. Treatment area should extend 50 feet beyond the last symptomatic stump in a center. Fallers have marked stumps by informal agreement on some sales. Diseased areas within harvest units need not be identified precisely if the entire unit is regenerated entirely to less susceptible species. However, this is not recommended because, on disease-free sites, Douglas-fir will undoubtably provide the highest yield, and the extra effort required to delineate disease centers for regeneration is probably cost-effective.

Regenerating less susceptible species within disease centers will reduce future losses. Planting IMMUNE--bigleaf maple, red alder; RESISTANT--western redcedar; or TOLERANT--blister rust resistant western white pine will minimize future losses and perpetuation of infective material in the soil. Following at least a 50-year rotation of such species and excluding Douglas-fir from the site, Douglas-fir could be safely grown. Western hemlock, a species intermediately susceptible to P. weirii, can be grown in disease centers with minimal loss over a generation, however, some trees may become infected, and a minimal amount of infection hazard may be present following harvest of that stand. As far as stand management is concerned, that hazard is at a low level acceptable to forest managers.

Light volcanic soil and the general westerly exposure may pose a problem in regenerating species that are susceptible to summer desiccation and exposure. The site in question naturally regenerated to almost pure Douglas-fir following the last major fire. Western hemlock and western redcedar are present in the current stand but they largely regenerated underneath a Douglas-fir canopy. Western white pine is probably the most hardy disease-tolerant species adapted to the site. Minimal current stocking may be due to lack of seed source or superior competition of Douglas-firs, or both. Use of shading cards or other methods of enhancing seedling survival should be assessed for western hemlock and perhaps western redcedar. Hardwoods, especially bigleaf maple, and perhaps red alder, would do well on the site.

When highly susceptible trees are replanted in untreated diseased areas, either to satisfy management objectives or lack of alternative species, a loss in yield of at least 50 percent can be anticipated by the end of rotation. To minimize such loss, the site must be treated by removing or rendering infected stubs and stumps sterile. Stump removal can be accomplished with heavy equipment or explosives. Soil disturbance, compaction, nutrient drain and steep topography are drawbacks to stump removal. The use of fumigants applied directly to infected stumps has been used as an experimental basis. Stump

fumigation avoids most of the problems associated with stump removal, however, it may have other unknown disadvantages since the system is still experimental. Costs for removing or fumigating stumps are high, $600 to $800 per acre. Because of associated hazard, potential impact and costs, these treatments, are not recommended.

Armillaria root rot centers should be treated similarly to laminated root rot in these stands. Pockets of mortality were characteristic of an aggressive strain of A. mellea; trees being killed were vigorous. Planting Douglas-fir in these centers would probably result in unacceptable losses. Planting western white pine, western hemlock or a hardwood is less hazarous. Following a rotation of a less susceptible species, the inoculum level would be reduced in order that Douglas-fir could safely be regrown.

Douglas-fir beetles are a periodic problem in these stands because root rot mortality and root rot-induced blowdown are allowing population buildups. As root rot centers are treated the beetle hazard will diminish.

As the area is roaded, salvaging of beetle-killed timber will be easier. Efforts should be made to quickly remove dead and dying trees and to monitor nearby fir for indications of recent attacks. Following windstorms, blowdown should be quickly removed to avoid production and dispersal of large broods of beetles.

Immature stands

Disease damage is not especially high in the young, fire originated stands within the surveyed area. This is probably because laminated root rot has not fully maninfested itself in this young age class. Infection is present in root systems of the previous stand, but appreciable mortality has not yet occurred. The disease situation should be reassessed prior to a commercial entry into these stands.

Table 1: Mean Basal Area (ft^2) and Trees Per Acre by Diameter Class, Species and Tree Condition, Hat Sale Area

DBH CLASS	DOUGLAS-FIR				WESTERN REDCEDAR	
	Alive		Dead		Alive	
	BA	TA	BA	TA	BA	TA
10	3.3	6.1	0.6	1.0		
12						
14						
16			1.2	0.8		
18						
20	6.7	3.1	1.1	0.5		
22	13.3	5.1	1.7	0.7		
24	16.7	5.3	1.2	0.4		
26	2.0	5.4	1.1	0.3		
28	23.9	5.6	1.1	0.3	3.3	0.8
30	30.6	6.2	2.3	0.5		
32	30.0	5.4	4.7	0.8		
34	33.3	5.3	2.9	0.5		
36	10.0	1.4	2.4	0.4		
38	16.7	2.1	1.2	0.2		
40	23.3	2.7	0	0		
42	6.7	0.7				
44	0	0	0.6	0.1		
46	3.3	0.3				
48	10.0	0.8				
50	0	0				
52	3.3	0.2				
Totals	247.8	55.7	22.1	6.5	3.3	0.8

273.2

Table 2: Mean Basal Area (ft.^{2}) and Trees Per Acre by Pest, Condition, and Diameter Class, Hat Sale Area

DBH CLASS	INFECTED LIVING TREES				INFECTED DEAD TREES								NON-DISEASED, WINDTHROWN, AND OTHER MORTALITY	
	P. weirii		*P. pini*		*P. weirii*		*D.pseudotsugae*		*A. mellea*		*P.schweinitzii*			
	BA	T/A	BA	T/A	BA	T/A	BA	T/A	BA	T/A	BA	T/A	BA	T/A
10							0.6	1.0						
12														
14														
16					0.6	0.4	0.6	0.4						
20													1.1	0.5
22					0.6	0.2							1.1	0.4
24					0.6	0.2			0.6	0.2				
26													1.1	0.3
28	0.6	0.1							1.1	0.3				
30	0.6	0.1					1.7	0.4					0.6	0.1
32			6.7	1.2	0.6	0.1	2.9	0.5			0.6	0.1	0.6	0.1
34					0.6	0.1	0.6	0.1					1.7	0.3
36					1.2	0.2					0.6	0.1	0.6	0.1
38					0.6	0.1	0.6	0.1						
40														
42														
44					0.6	0.1								
TOTAL:	1.2	0.2	6.7	1.2	5.4	1.4	7.0	1.5	1.7	0.5	1.2	0.2	6.8	1.8